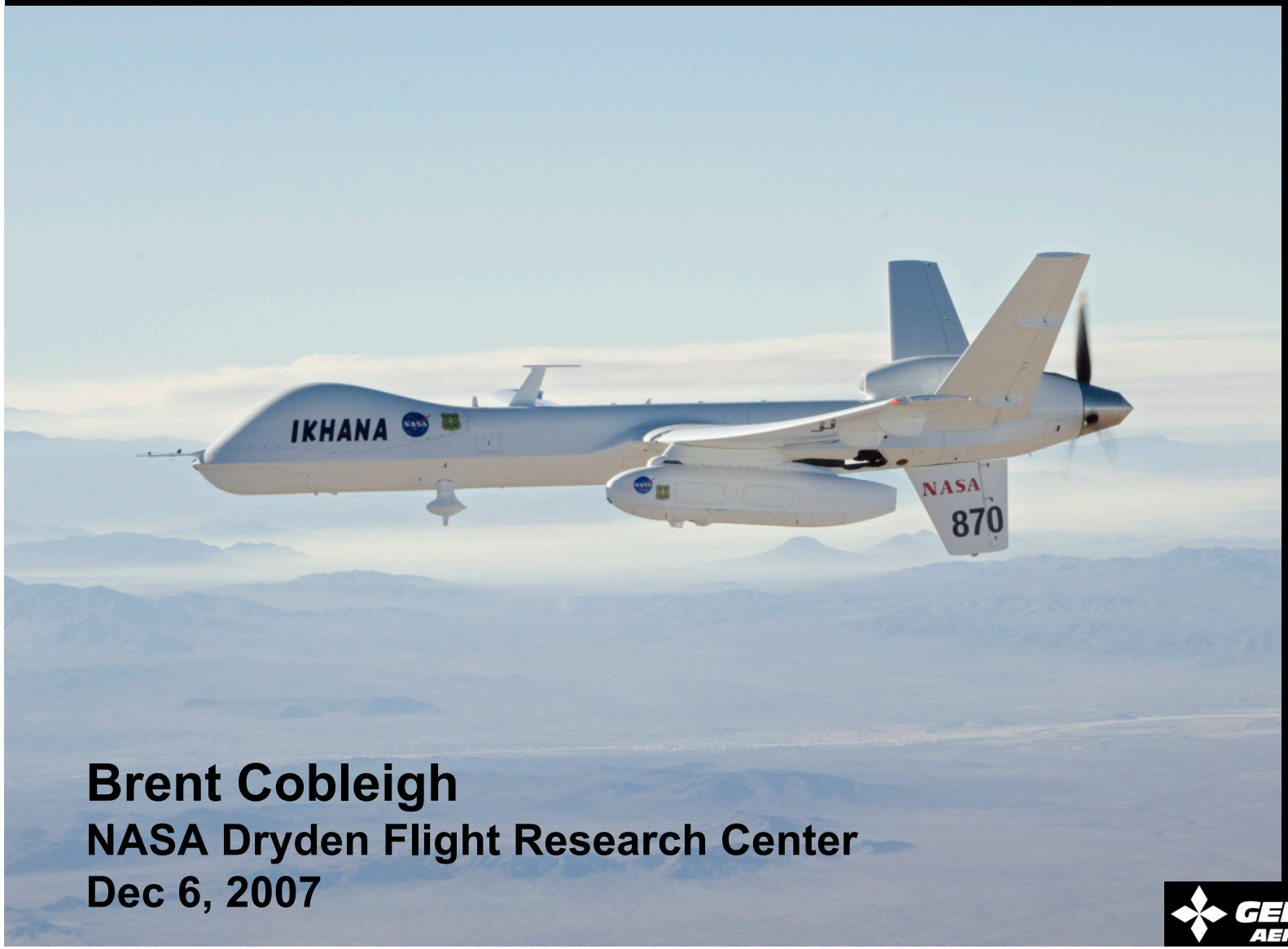
Emergency Response Fire-Imaging UAS Missions over the Southern California Wildfire Disaster

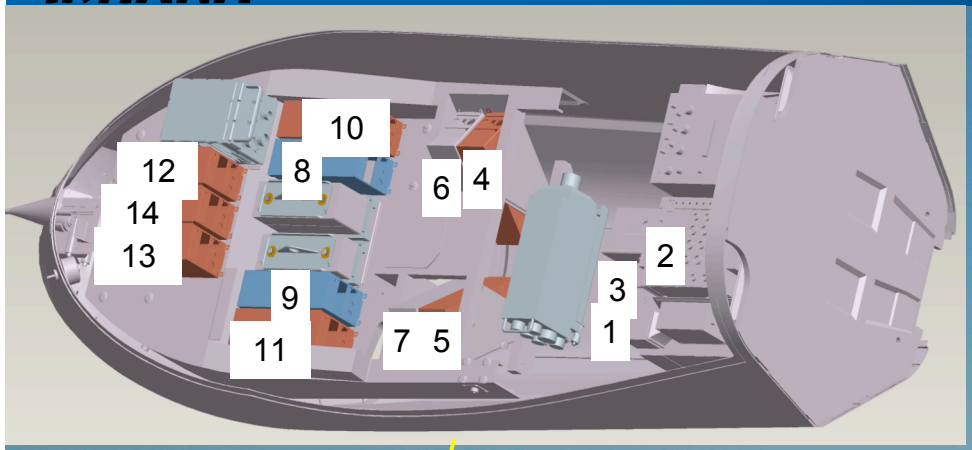


Brent Cobleigh
NASA Dryden Flight Research Center
Dec 6, 2007

GENERAL ATOMICS
AERONAUTICAL SYSTEMS

Western States Fire Mission Modifications

IKHANA



Back-up battery power increased to 3 hours

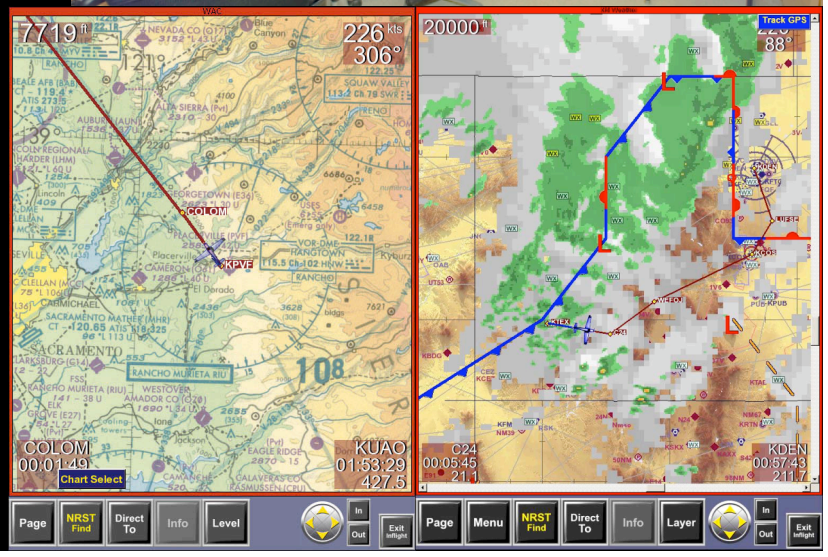
Wiring connections from pod to power distribution, GPS antenna, and SatCom system

Infrared Wildfire Scanner

Ground Systems

IKHANA

- Mobile Ground Control Station
  - Dual pilot control station
  - Electronic navigation charts
  - Weather
  - 6 Engineering/Science workstations
  - Range safety workstation
  - Intercom system throughout
  - Overhead mission displays
  - Telephones
  - Remote video from aircraft start-up/shut-down site
  - Downlink video and data recording
- Mobile 2.4m Ku SatCom Antenna
  - Dual redundant receiver/transmitters



2007 Western States Fire Mission Objectives

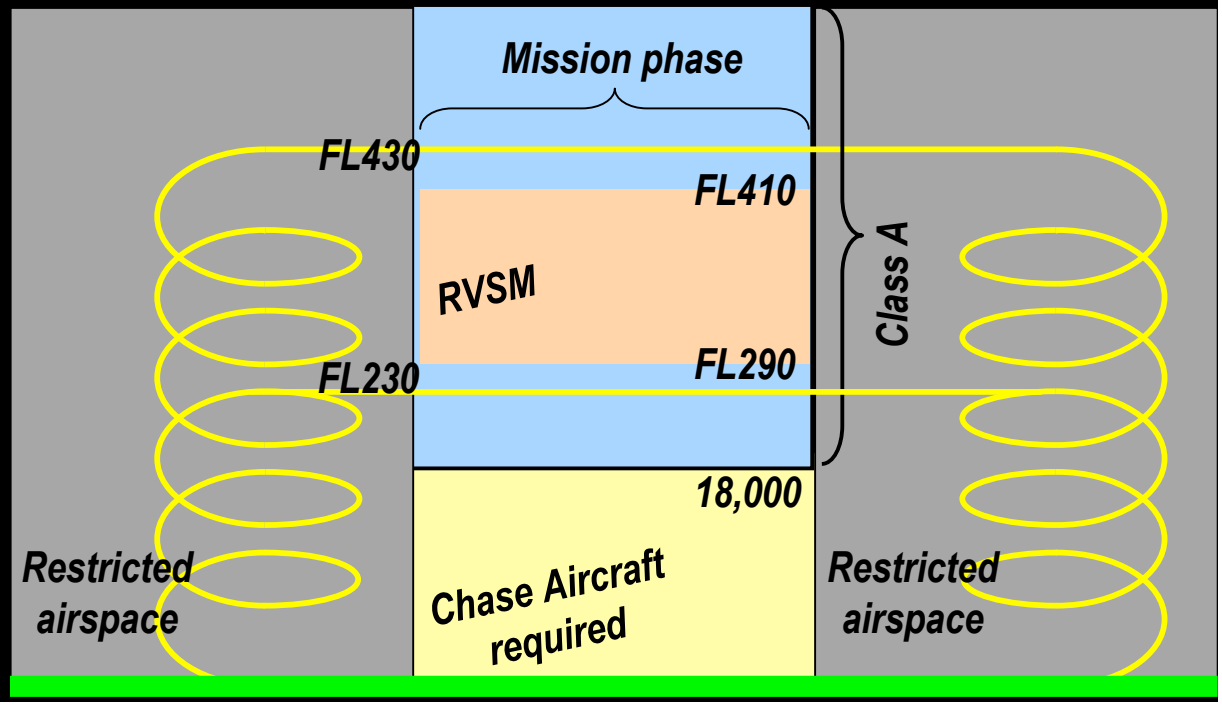
IKHANA

- Demonstrate capabilities of UAS to overfly and collect sensor data on widespread fires throughout Western US.
- Demonstrate long-endurance mission capabilities (20-hours+).
- Image multiple fires (greater than 4 fires per mission), to showcase extendable mission configuration and ability to either linger over key fires or station over disparate regional fires.
- Demonstrate new UAV-compatible, autonomous sensor for improved thermal characterization of fires.
- Provide automated, on-board, terrain and geo-rectified sensor imagery over OTH satcom links to national fire personnel and Incident commanders.
- Deliver real-time imagery (within 10-minutes of acquisition).
- Demonstrate capabilities of OTS technologies (GoogleEarth) to ‘serve’ and display mission-critical sensor data, coincident with other pertinent data elements to facilitate information processing (WX data, ground asset data, other satellite data, R/T video, flight track info, etc).

Operations Concept

IKHANA

- Chase aircraft required below 18k in the U.S. National Airspace (NAS)
- Air traffic control (ATC) used for collision avoidance above 18,000 ft
- NASA Dryden uses restricted airspace to climb to cruise altitude before exiting into the NAS
- Since Ikhana not qualified for Reduced Vertical Separation Minima (RVSM), operations are limited to 18,000 ft to FL 290 or above FL 410
- Transponder and radio communication required

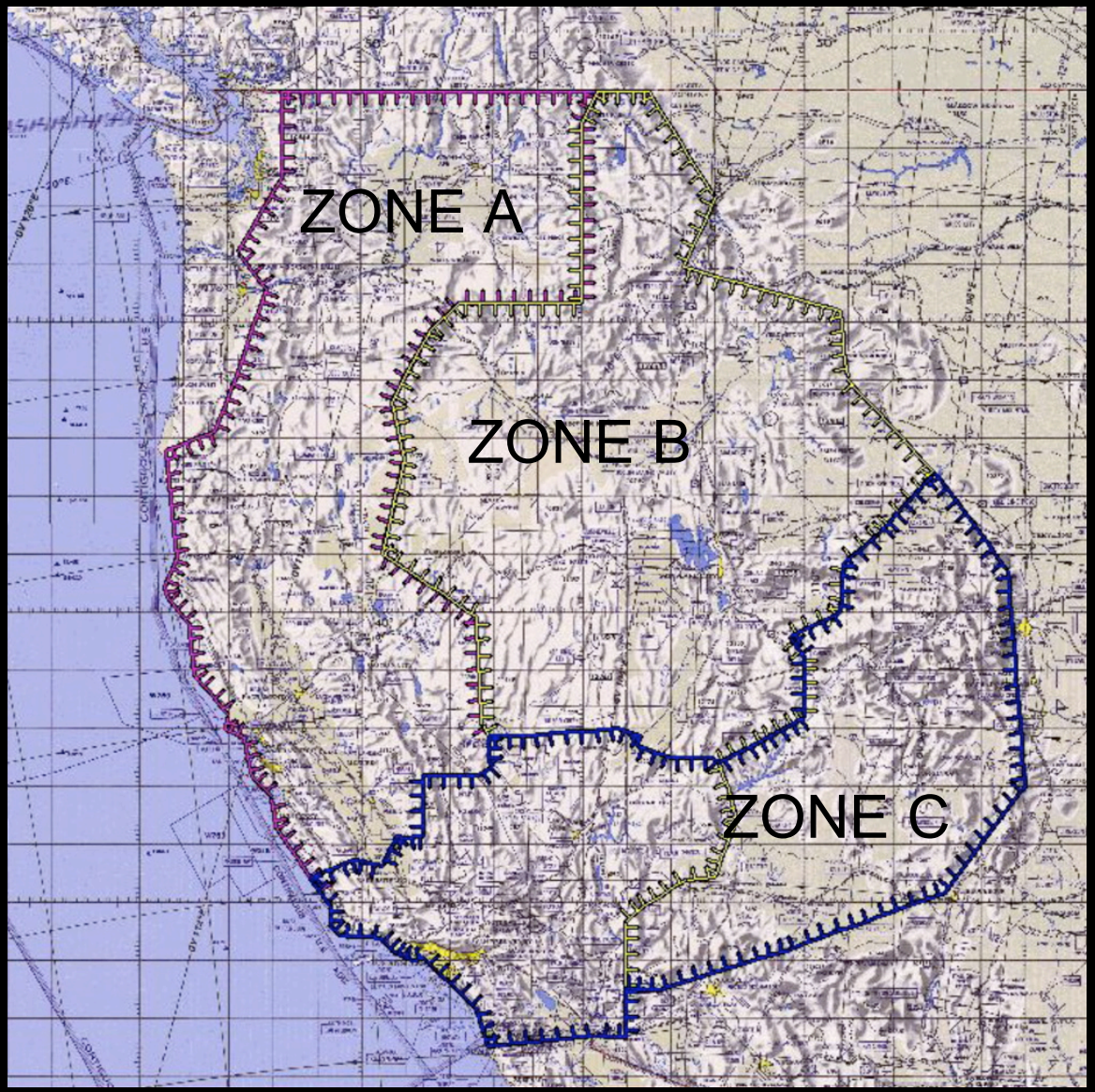


Certificate of Authorization (COA) Boundary Request

IKHANA

3 Operational Zones

Each zone includes no more than 3 ARTCC areas

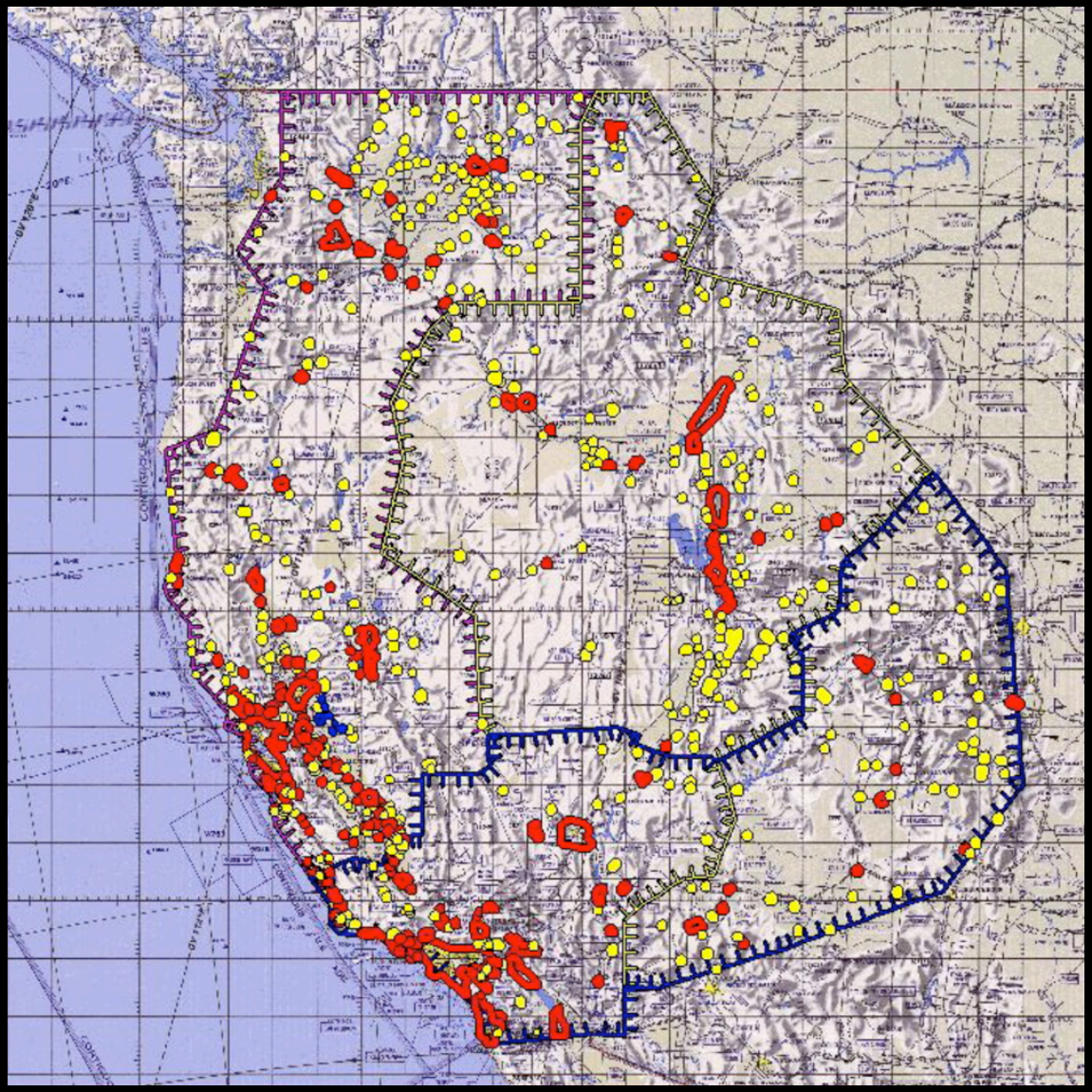


Range Safety Protection Zones

IKHANA

KEEP-OUT ZONES

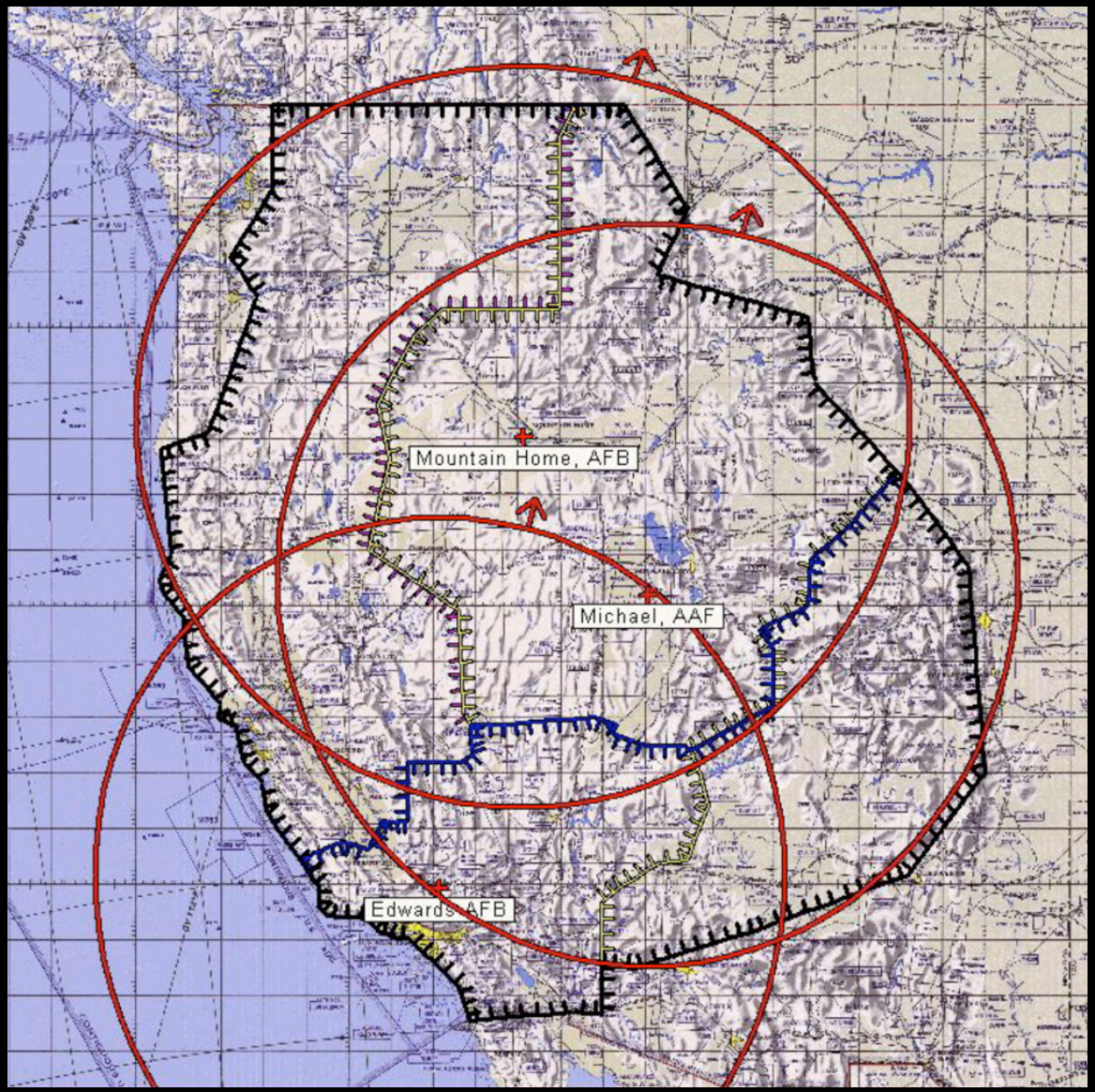
- NOMINAL AIRCRAFT
- UNHEALTHY AIRCRAFT



Primary Emergency Landing Sites

IKHANA

- Radius =400 nmi
- Minimum Range on Battery Power
- Aircraft has single generator
- Landing agreements negotiated with each site



Secondary Emergency Landing Sites

IKHANA

Radius=50 nmi

Minimum glide distance from 23,000 ft

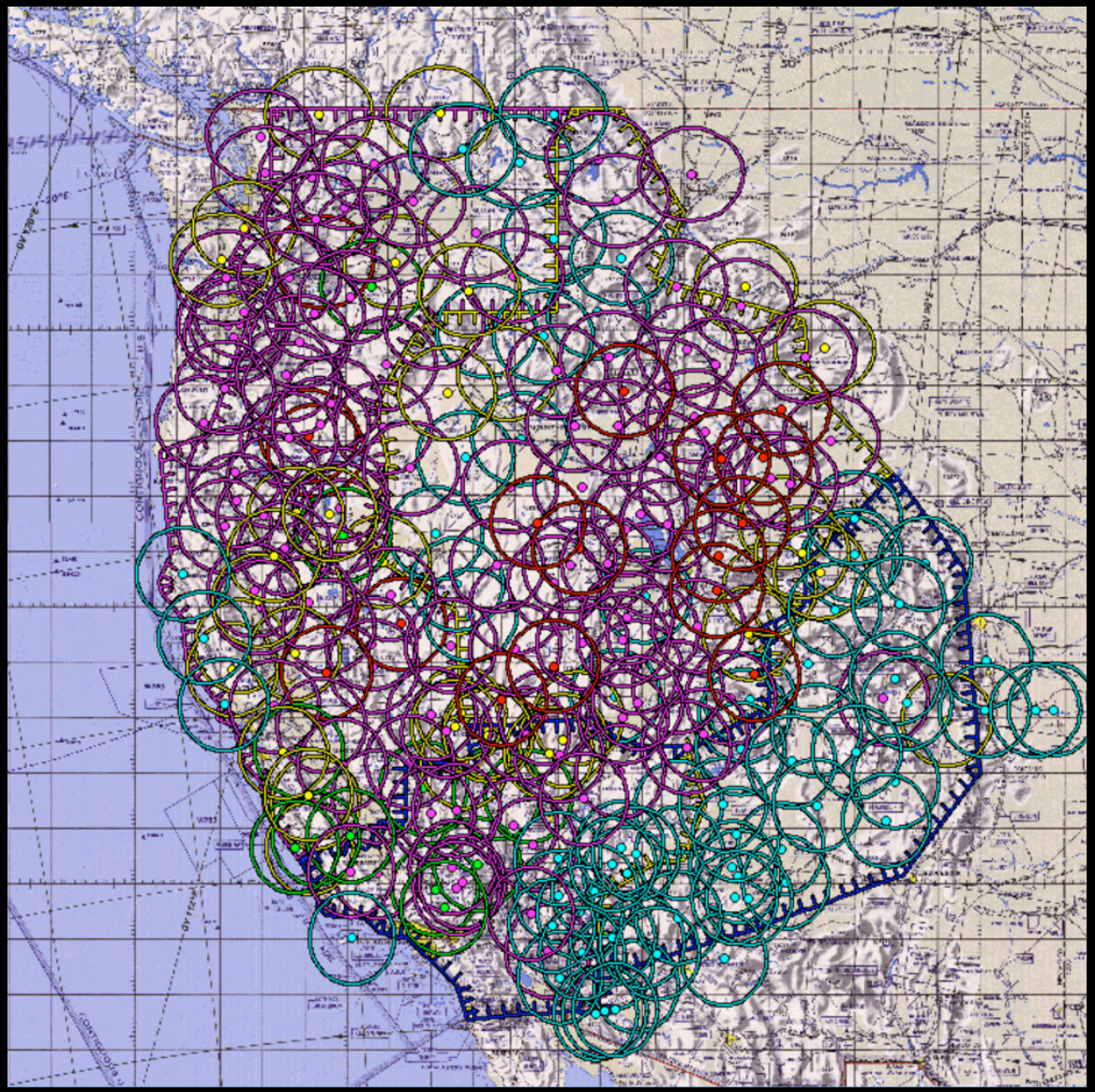
Over 280 sites identified

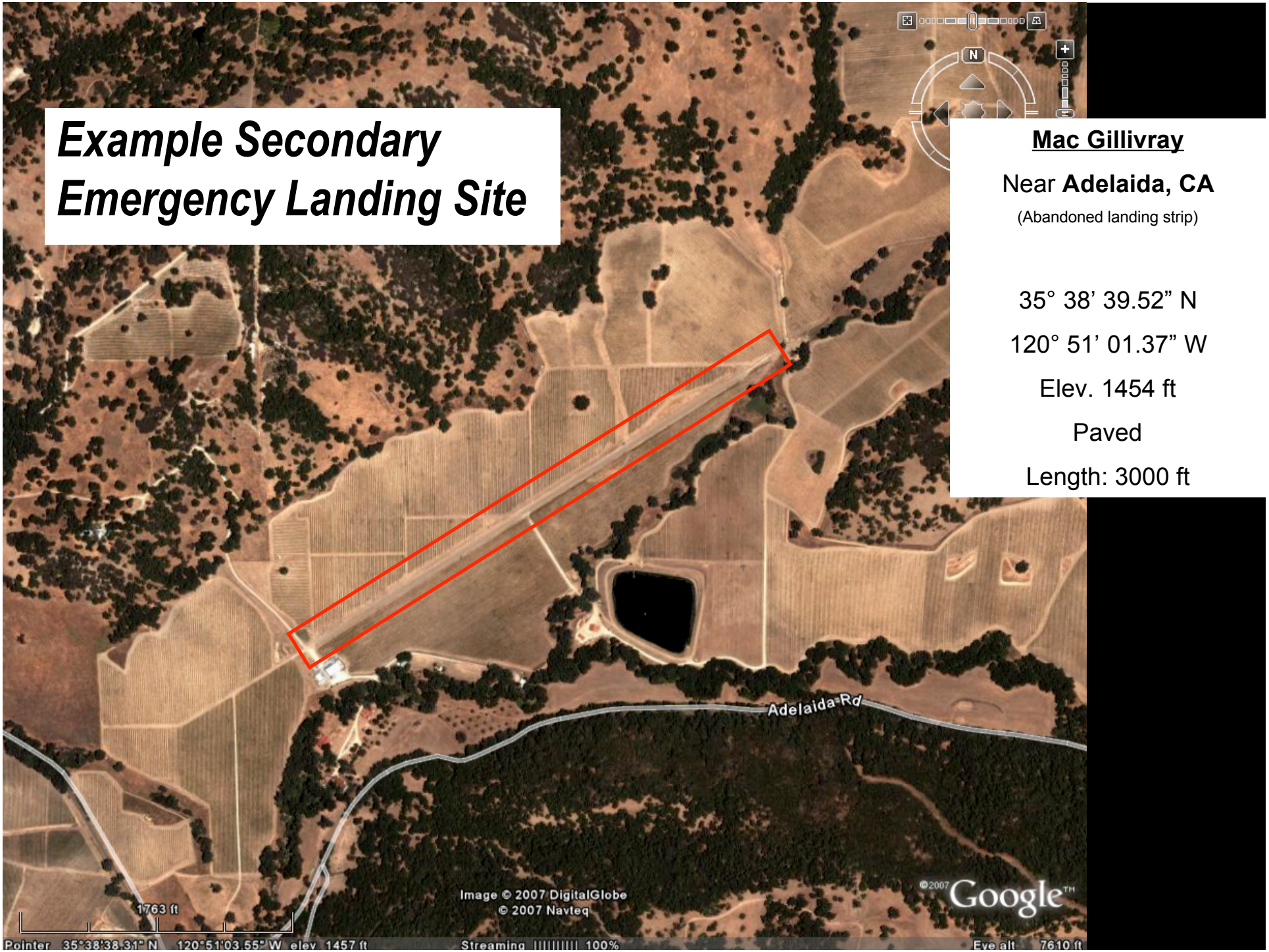
Categorized Green, Yellow, Purple, Red by pilots

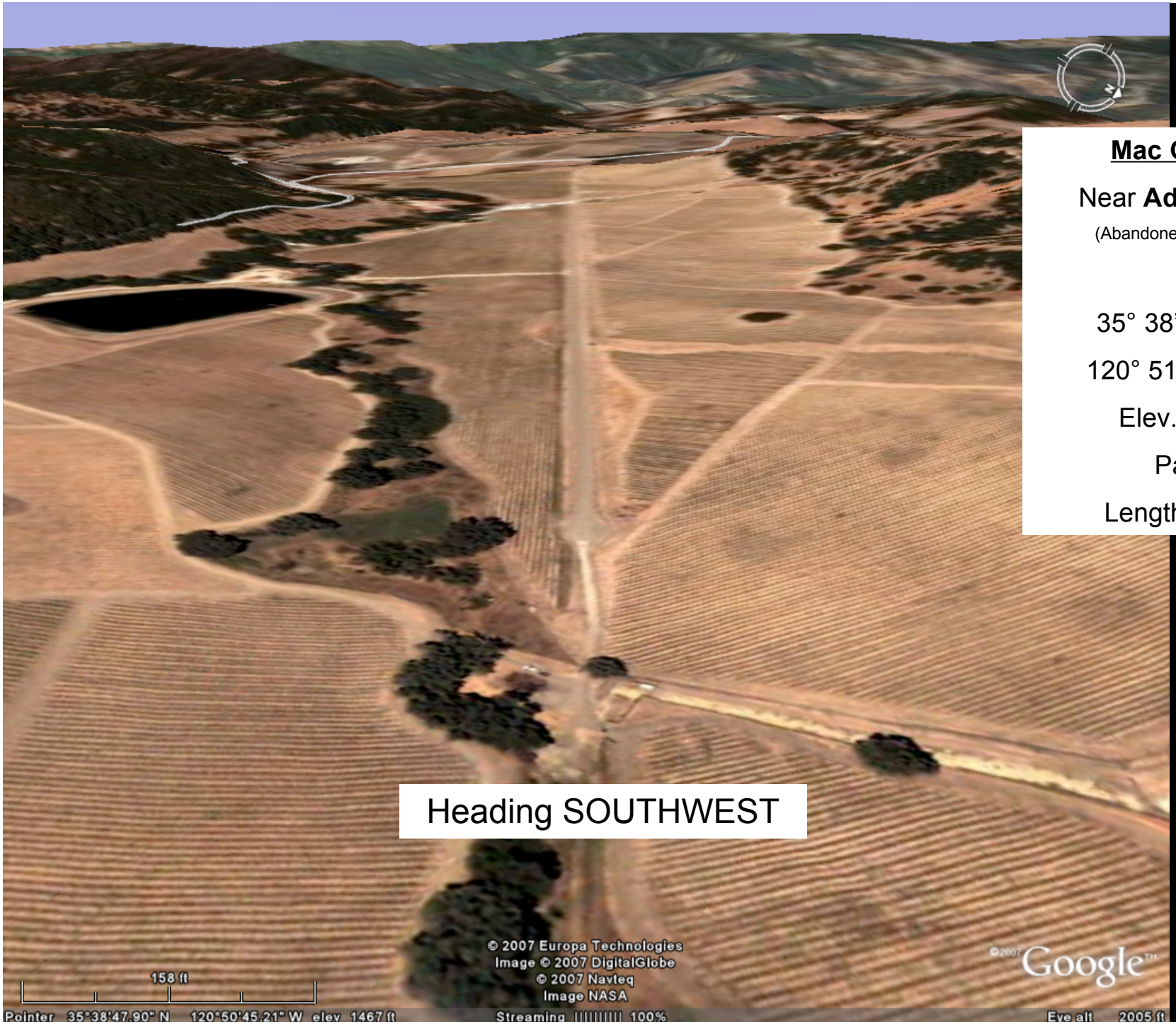
Selected in unpopulated areas. Abandoned runways, dry lakebeds, flat ground, ditch areas

Primary purpose is to protect public

Actively managed during each mission




Example Secondary
Emergency Landing Site
Mac Gillivray
Near Adelaida, CA
(Abandoned landing strip)
35° 38’ 39.52” N
120° 51’ 01.37” W
Elev. 1454 ft
Paved
Length: 3000 ft
Adelaida Rd
1763 ft
Image © 2007 DigitalGlobe
© 2007 Navteq
©2007 Google
Pointer 35°38'38.31" N 120°51'03.55" W elev 1457 ft
Streaming 100%
Eye alt 7610 ft



Mac Gillivray

Near **Adelaida, CA**

(Abandoned landing strip)

35° 38’ 39.52” N

120° 51’ 01.37” W

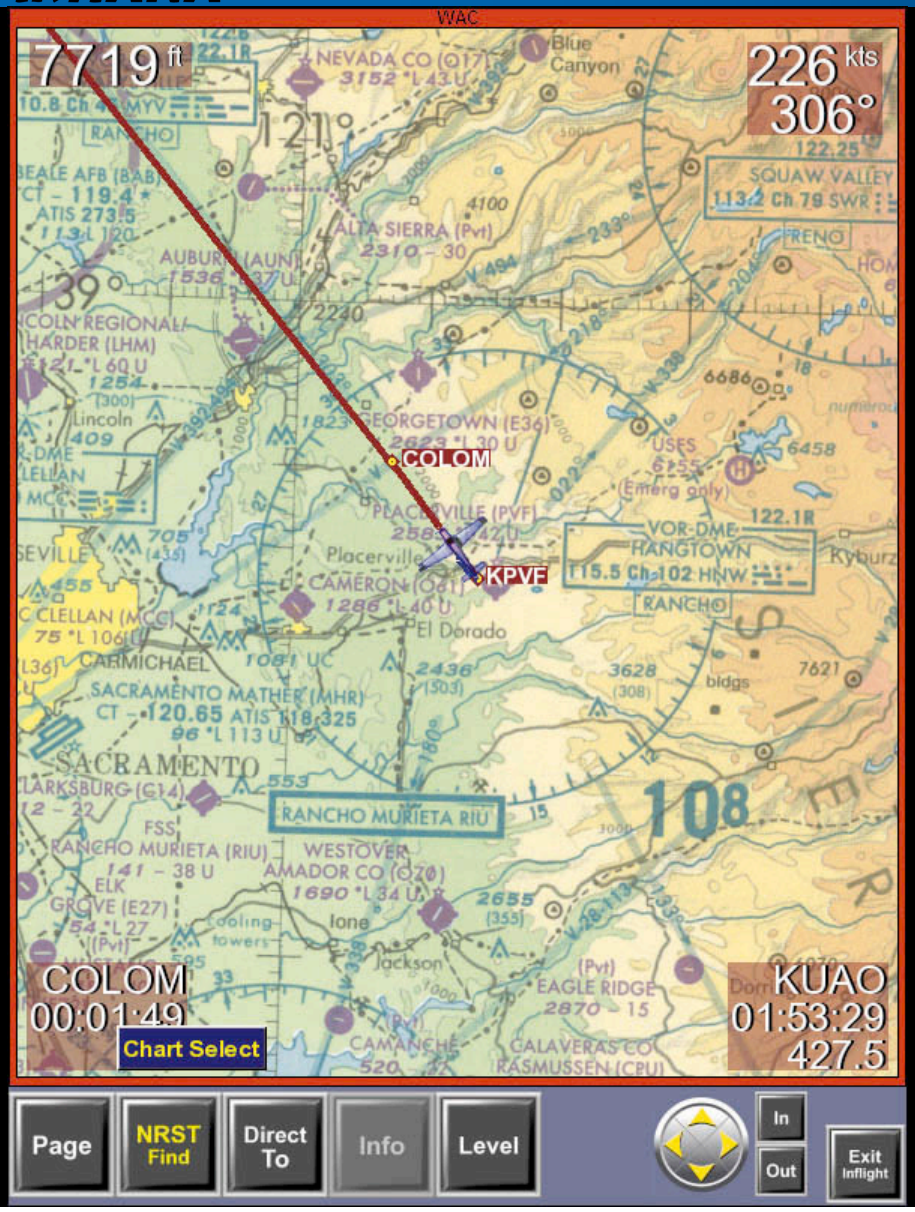
Elev. 1454 ft

Paved

Length: 3000 ft

Chart Case Professional

IKHANA



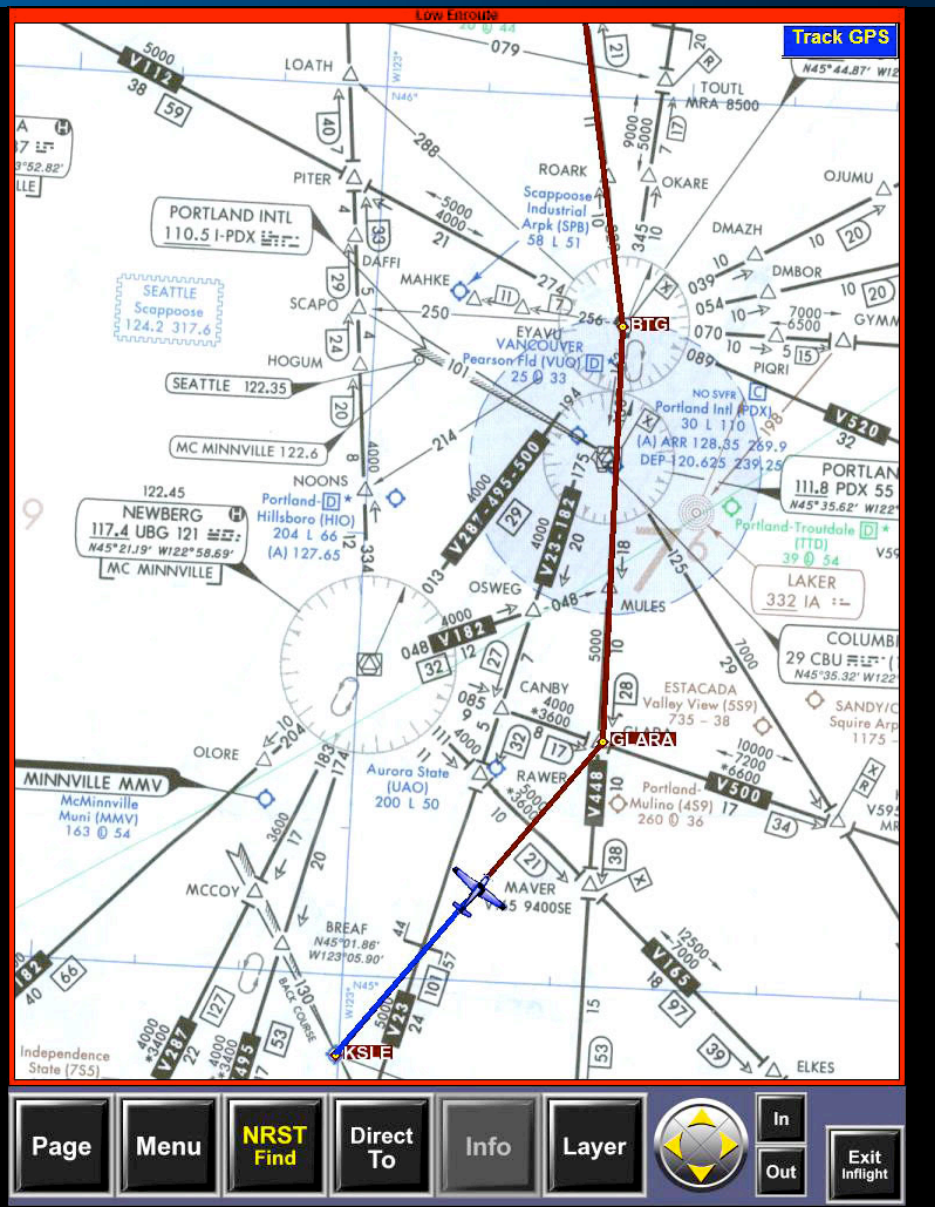
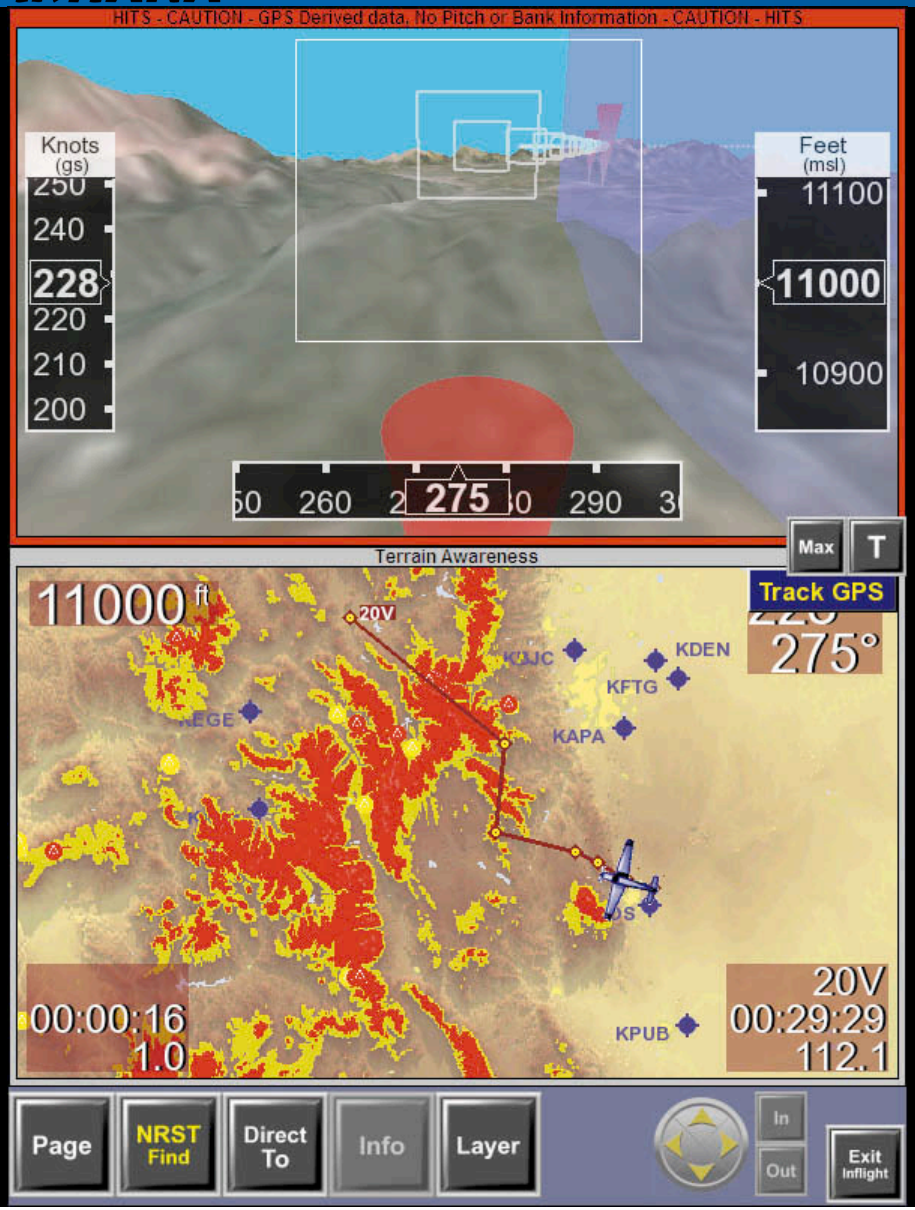
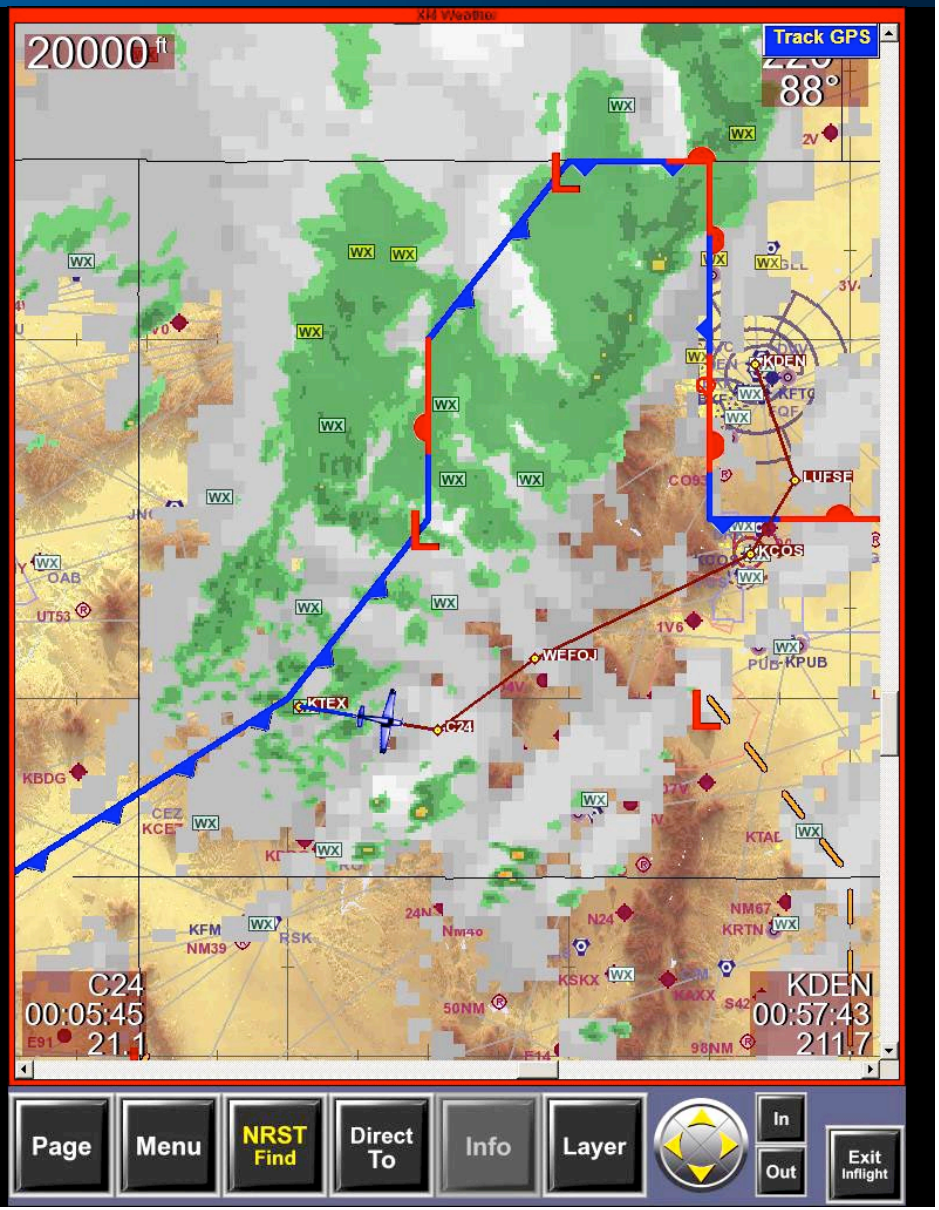


Chart Case Professional

IKHANA





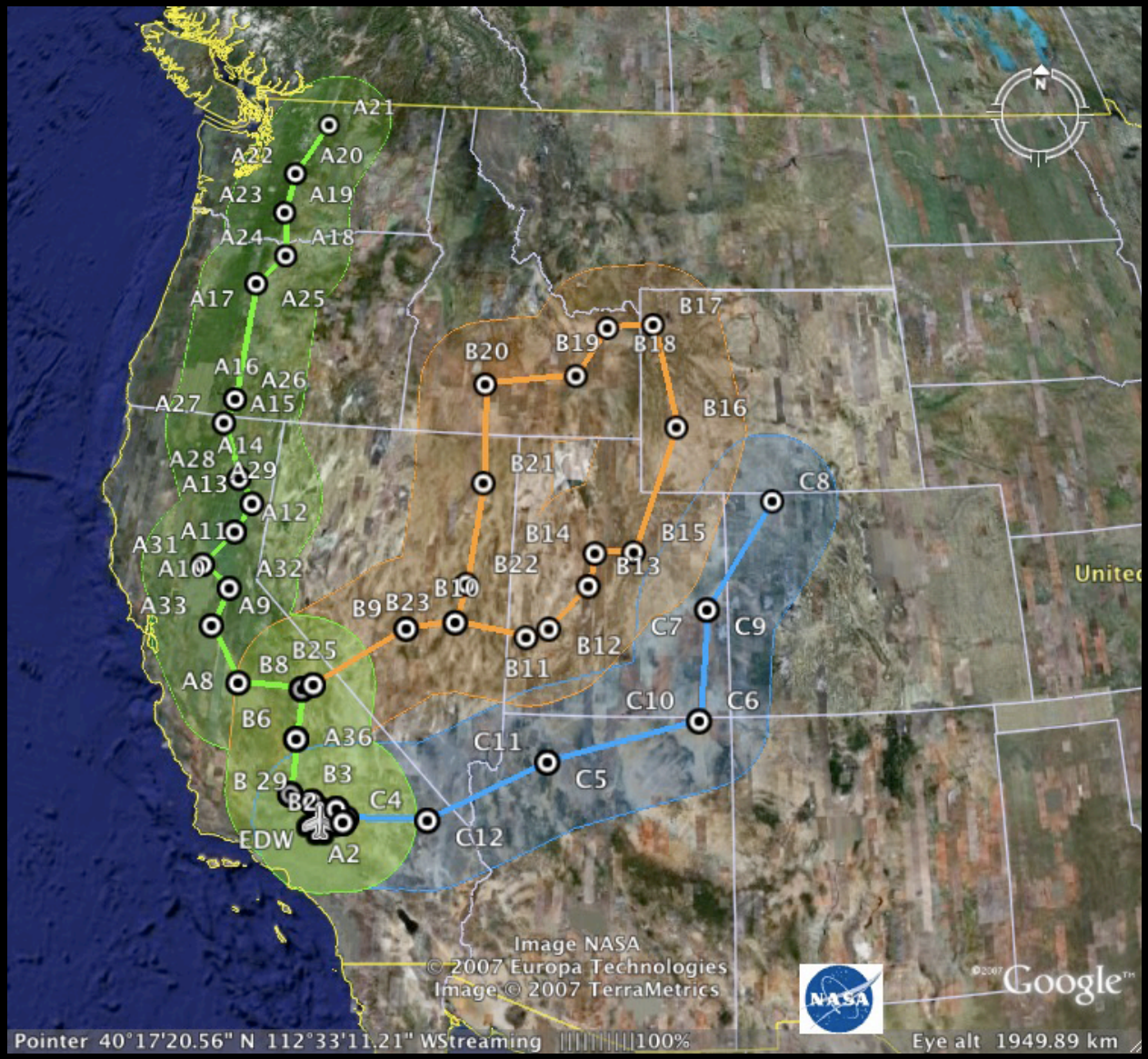
COA: Special Provisions

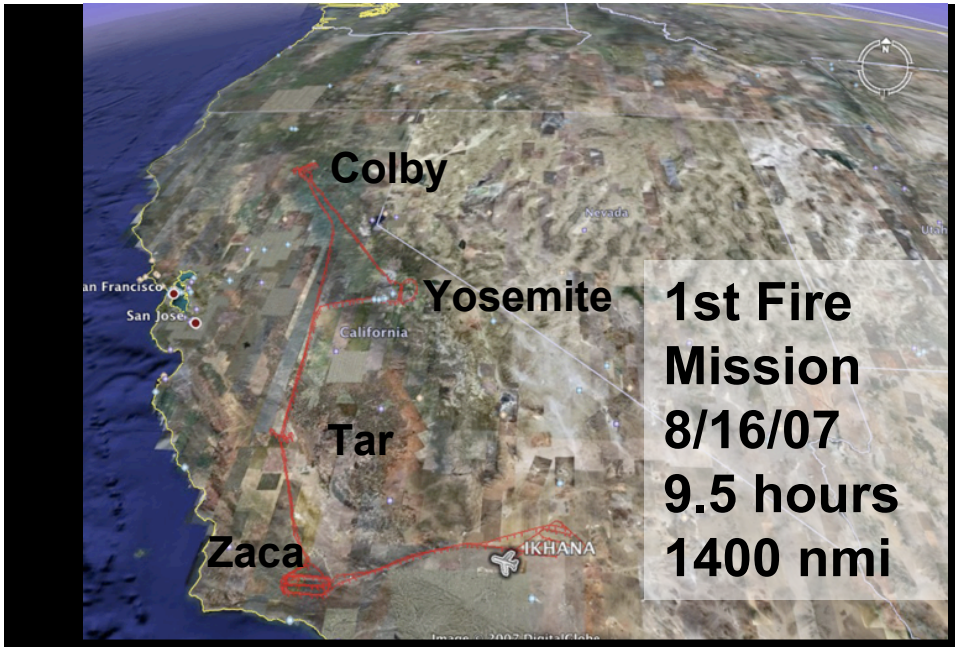
IKHANA

- Remain within 75nm of ‘backbone’ route
- Point to point flight plan
- 3 business day mission notification to FAA
- No flight in to forecasted “moderate or severe” turbulence
- No flight in area where convective SIGMET has been issued
- No flight in area of known or forecast icing
- Lost link procedure: continue on route for 15 min
- No flight in area of affected by GPS testing, solar storms or RAIM outages

Approved COA Area

IKHANA

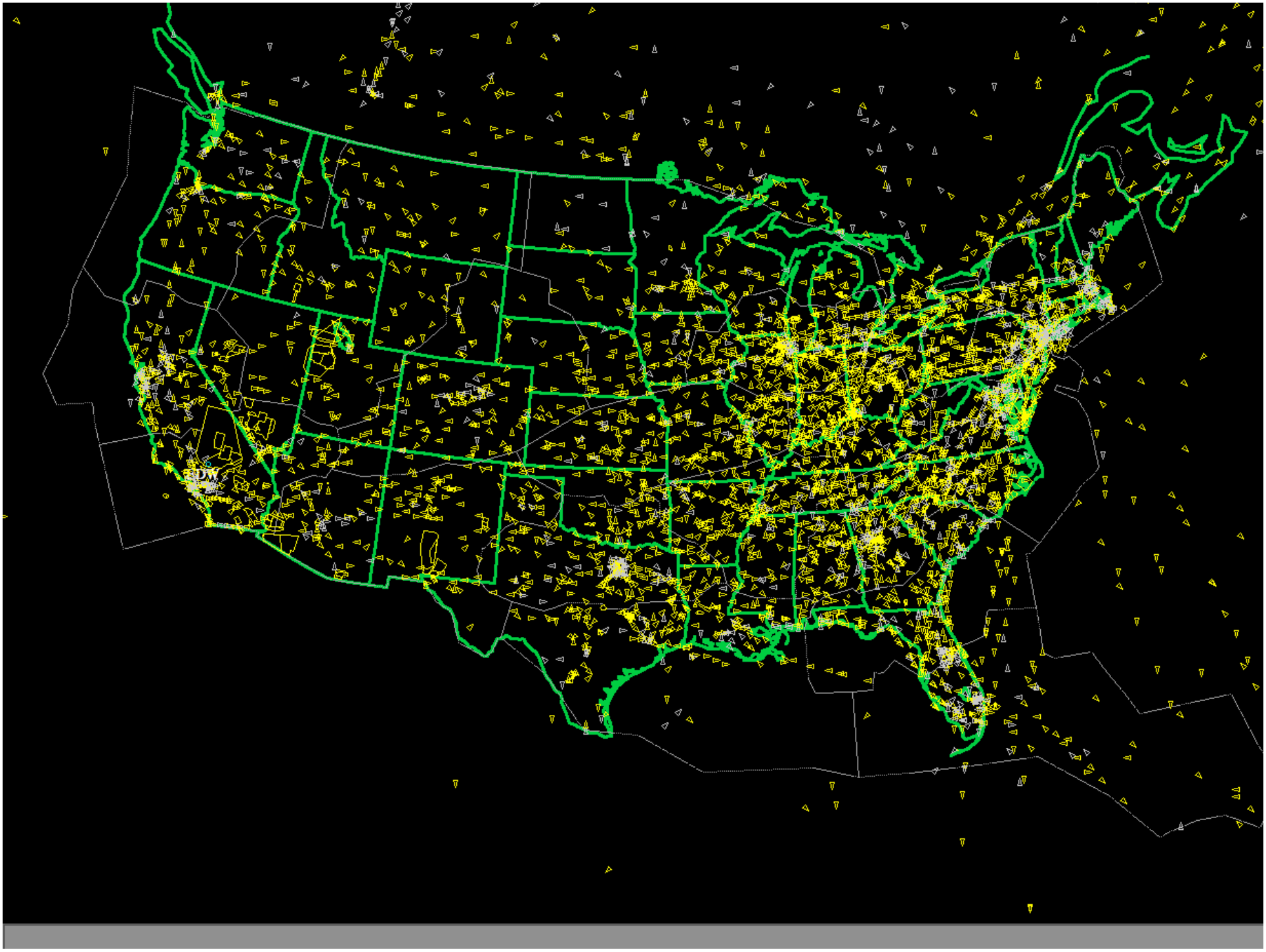



Colby
Yosemite
Tar
Zaca
IKHANA
1st Fire
Mission
8/16/07
9.5 hours
1400 nmi


Domke Lake
GW
Big Bend
Moonlight
Lick
Middle T
Grouse
Zaca
IKHANA
North
Fairmont
3rd Fire
Mission
9/7/07
20 hours
3200 nmi


Castle Rock
WH Complex
Trapper Ridge
Columbine
IKHANA
2nd Fire
Mission
8/29/07
16.1 hours
2500 nmi

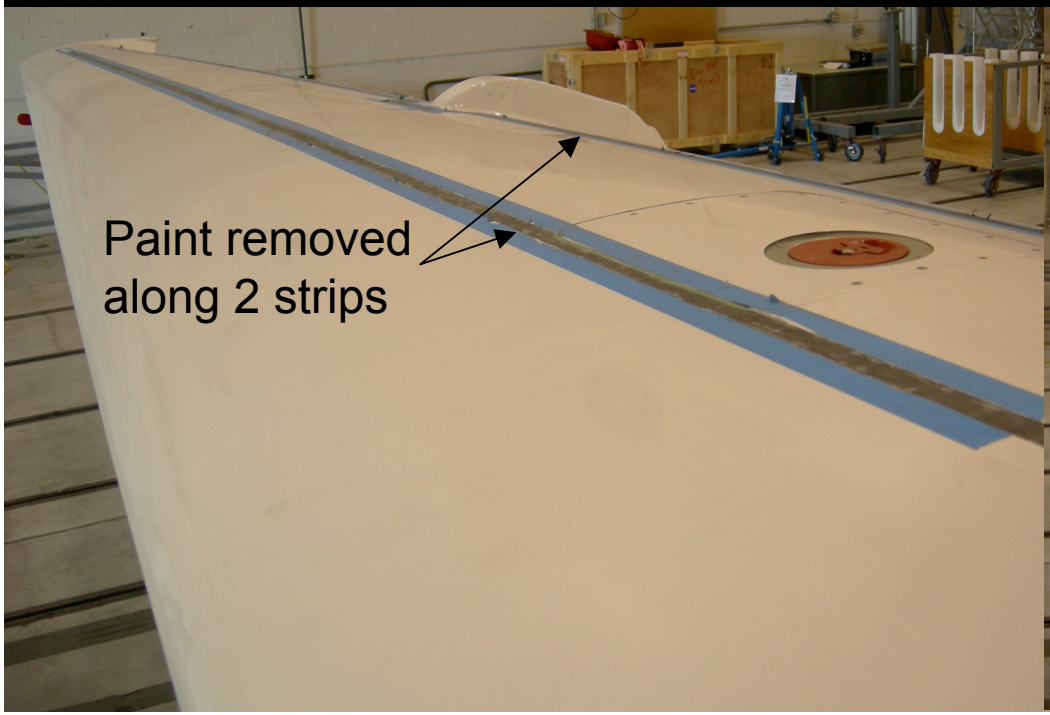

Moonlight
Lick
Grouse
IKHANA
Butler
4th Fire
Mission
9/27/07
10 hours
1800 nmi

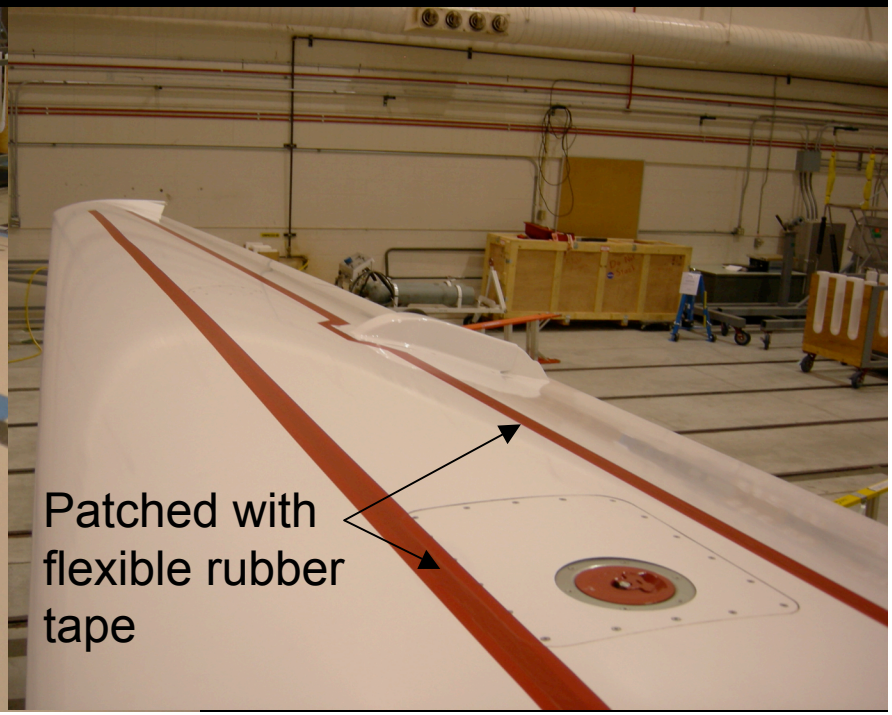


California Emergency Wildfire Response

IKHANA

- Oct 20-21: High winds >50 MPH drive wildfire in 4 southern California counties
- Oct 22nd: Ikhana team began preparation for a possible fire mission
- Two impediments to launching a mission
  - Failed hard drive in the wildfire sensor
  - Ikhana wings being modified for fiber-optic wing sensor demonstration
    - Tiger team assembled to assess airworthiness





California Emergency Wildfire Response

IKHANA

Oct 22nd

- Ikhana Project team contacted by California Office of Emergency Services requesting imagery of Southern California wildfires
  - Kim Zagaris, Chief Fire and Rescue Branch
  - 500,000 people evacuated
  - More than 11 fires burning
- Planning telecons held with NASA teams and USFS
- FAA notified
- Range safety office began reviewing population centers around fire areas
- NASA Ames and USFS teams deploy to Southern California
- Wing repair completed

Oct 23rd

- Sensor hard drive repaired and verified
- FAA extended COA to within 10 mi of Mexican border within hours of request
- Mission plan submitted to FAA
- Tech Brief of mission plan delivered to NASA Dryden Management

Oct 24th

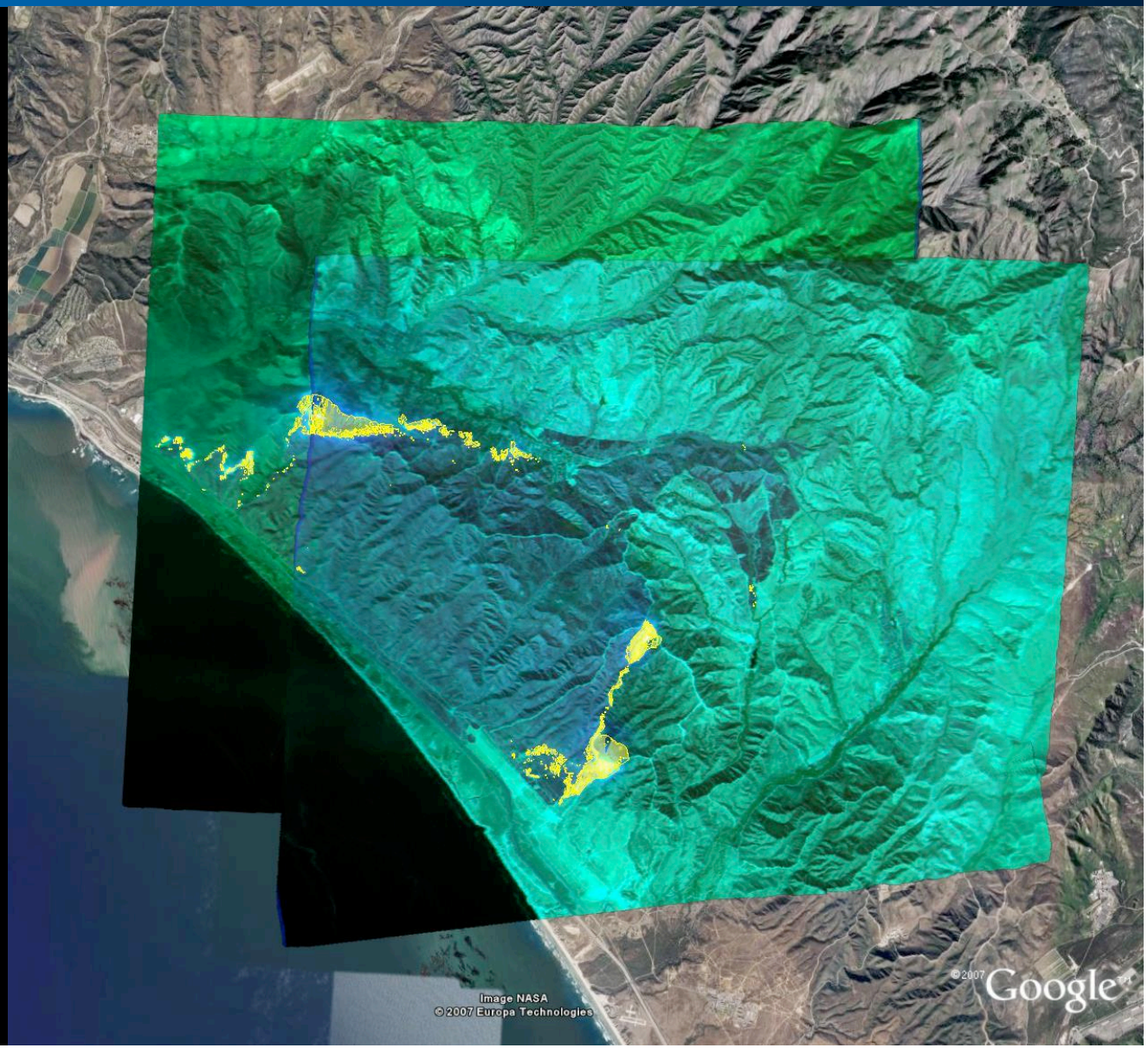
- Launched 1st emergency response mission @ 9am


Edwards AFB
IKHANA
~1350 nmi route
~9 hours
Ranch, Buckweed
Grass Valley, Slide
Los Angeles
Anacapa Island
Riverside
Anaheim
Santa Ana
Long Beach
Santiago
Rice
Ammo
Poomacha
Witch
Santa Catalina Island
Nicolas Island
San Clemente Island
Harris
Image NASA San Diego
© 2007 Europa Technologies
Image © 2007 DigitalGlobe
Pointer 33°51'09.31" N 117°19'07.50" Welev 664 m
Streaming 100%
Eye alt 374.54

Ammo Fire, Oct 24th

IKHANA

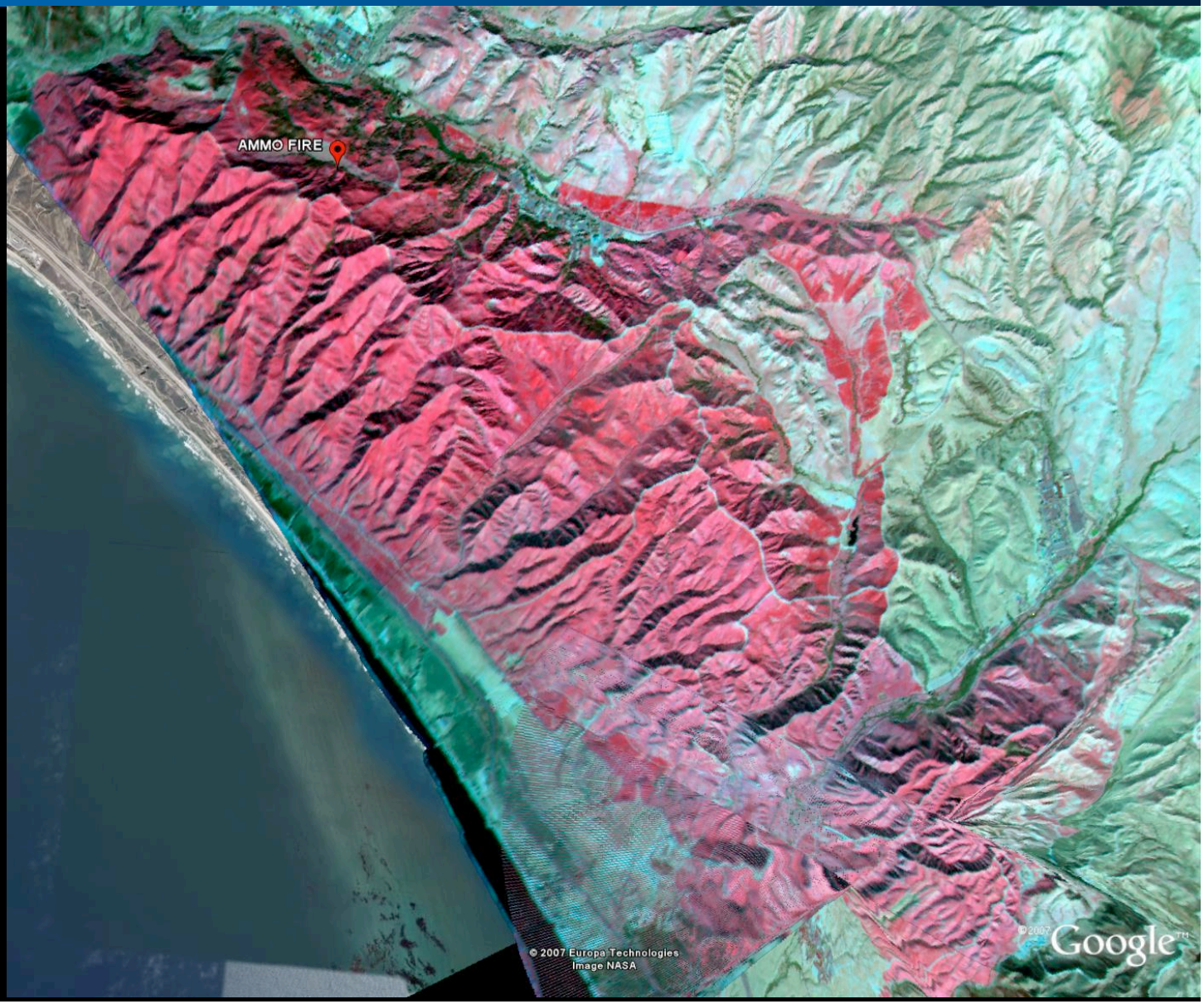
Hot spots in yellow



Ammo Burn Area, Oct 28th

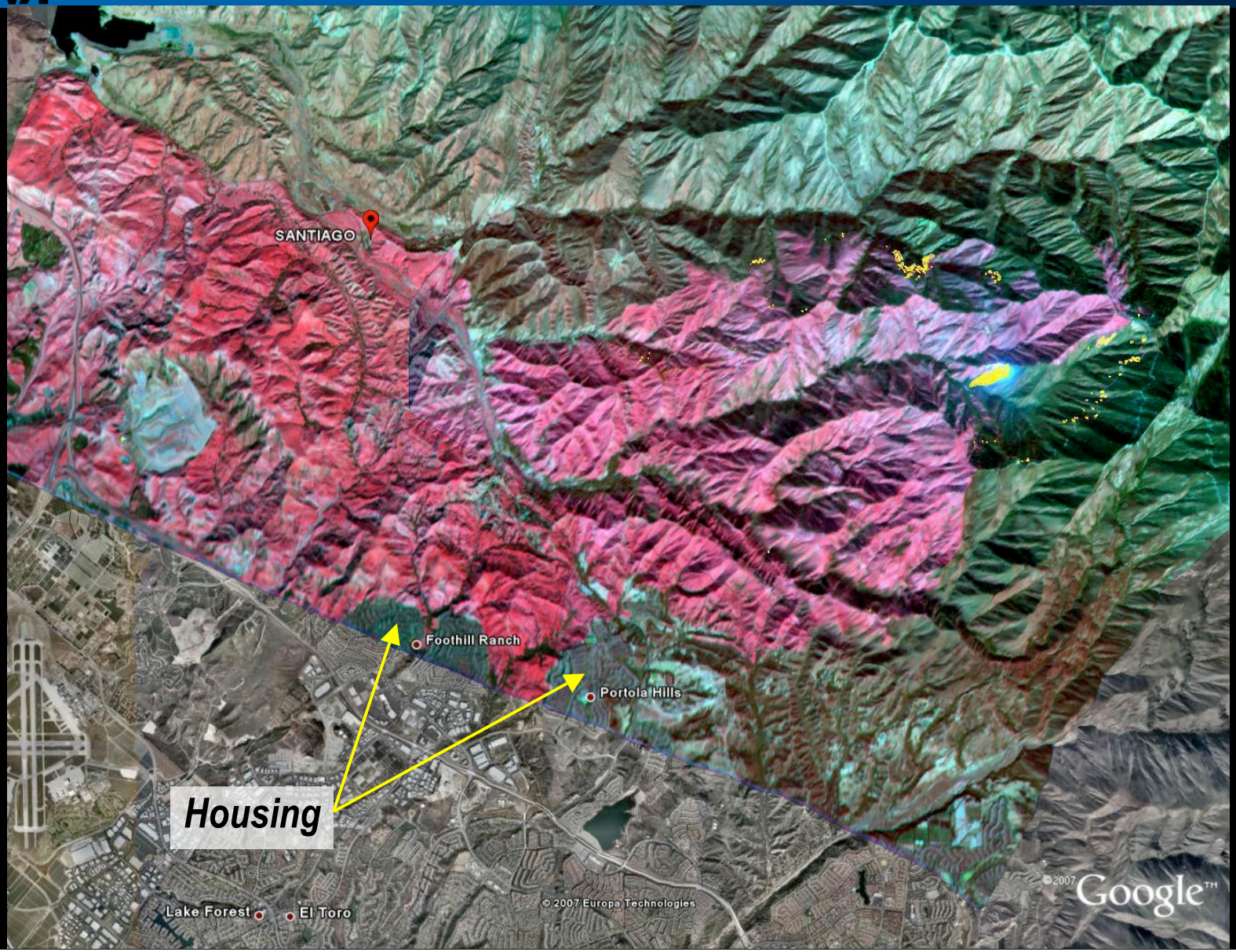
IKHANA

Sensor optimized for Burn Area Emergency Response (BAER) imagery



Santiago Fire, Oct 28th

IKHANA



Mission Results

IKHANA

- Four 9-hr missions flown over 5 day period
- Thermal infrared imagery delivered in near real-time (5 to 15 minutes) to:
  - Emergency ops: FEMA, NIFC, NorthCom, California EOC
  - Individual Fire Incident Commands
- Air Traffic Control gave excellent support
  - Mission plans flown in reverse
  - Real time requests for revisits of active fires
  - Added new fire during mission
  - Moved fire loiter points as fires moved
  - Earlier in summer, significant real-time reroute around thunderstorm activity
- Post Mission telecons with FAA were held to review mission and plan for next day
  - No issues with air traffic control during the 8 fire missions flown over the summer


Questions?
IKHANA
NASA
870